# 2,5-Cyclohexedienones. 4. Reactions of 4-Bromo-2, 4, 6-tri-tert-butyl-2, 5-cyclohexadien-1-one with Glycols

Fukata, Goki Department of Molecular Science and Technology, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University

Tashiro, Masashi Department of Molecular Science and Technology, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University

https://doi.org/10.15017/17525

出版情報:九州大学大学院総合理工学報告.3(1), pp.9-12, 1981-06-30.九州大学大学院総合理工学研 究科 バージョン:

権利関係:

## 2,5-Cyclohexedienones. 4. Reactions of 4-Bromo-2,4,6-tri-tert-butyl-2,5-cyclohexadien-1-one with Glycols

## Gouki FUKATA and Masashi TASHIRO\* (Received February 10, 1981)

Reactions of 4-bromo-2, 4, 6-tri-t-butyl-2, 5-cyclohexadien-1-one (1) with ethylene glycol (2a), and di-(2b) and triethylene glycol (2c) were carried out under various conditions. Pyridine can act as a good catalyst for the preparation of the corresponding dienoxy alcohols (3a-c). However,  $\omega$ ,  $\omega'$ -bis (4-oxo-2, 5-cyclohexadien-1-yl) ethers (4a-c) were obtained in considerable yields only when  $\alpha$ -picoline was used as a catalyst.

In a series of papers, we have shown, as illustrated in Scheme 1 below, a new and convenient method for the selective preparation of o- and p-substituted phenols by utilizing a reaction of 4-bromo-2, 4, 6-tri-tert-butyl-2, 5-cyclohexadien-1-one (1)<sup>1)</sup>, which can be easily prepared by a bromination of 2, 4, 6tri-t-butylphenol (5), with nucleophilic reagents such as sodium phenolate<sup>2)</sup>, amines<sup>3)</sup>, alcohols<sup>4)</sup>, and pyridines<sup>5)</sup>.

In this paper is reported the reaction of 1 with ethlene glycol (2a) and di-(2b)-and triethylene glycol (2c). The results are summarized in Scheme 2 and the Table 1.

When dienone (1) was heated in a large excess amount of glycol (2) under a stream of nitrogen with stirring at 110°C (bath temperature) in the presence of pyridine (in the molar ratio of 2: 1 to 1), the corresponding dienoxy alcohol (3) was obtained in ca. 70% yield. It was also found that  $\omega, \omega'$ -bis (4-oxo-2, 5-cyclohexadien-1-yl) ethers 4a and 4b were obtained in poor yields as minor products in the cases of 2a and 2b, respectively, but not from 2e, even though

these reactions were carried out in a large excesses of glycols<sup>6)</sup>. Furthermore, an interesting phenomenon was observed when the reactions were carried out without stirring, namely, the yields of 4a and 4b increased from 0.4 % to 19% and from 0.1% to 6%, respectively. In the case of 2c, however, there was identified scarcely any corresponding compound 4, even without stirring. It is not yet completely clear why such different results are obtained, but we might say that the difference may be due to the solubility of 1 in glycols used, since 1 is only slightly soluble in 2a, somewhat soluble in 2b, but easily soluble in 2c under the reaction conditions.

The structures of the products **3a-3c**, **4a** and **4b** are fully supported by their elemental analysis, 'H-nmr, ir- and mass spectra.

It has already been reported" that the reaction of 1, 2a and pyridine in molar ratio 1: 1-2: 2, where the possibility for the formation of 4a seemed to be preferred judged by the molar ratio, afforded the unexpected product, 1-(3,5-di-t-butyl-2-hydroxyphenyl)pyridinium bromide (8) in yield of 43 % together with 5, 2, 6-di-tert-butylbenzoquinone

<sup>\*</sup> Department of Molecular Science and Technology

- 10 ---



Scheme 1



(6) and 2, 4, 6-tri-t-butyl-4-hydroxy-2, 5cyclohexadien-1-one (7) as minor products, but not 4a. It was now, however, found that in this reaction when  $\alpha$ -picoline was used instead of pyridine, the expected product 4a could be obtained in yield of 38 % besides 3a, 5, 6 and 7 in 38, 0.1, 2 and 2% yields, respectively. And it was observed in the case of 2bthat on the formation of 4b, the yield increased from 6% to 10% (see run 5 and 6). Furthermore, it was observed

Run	2	Products (Yield, %) <sup>b)</sup>
1 2c) 3d) 4 5c) 6d) 7	a a b b b b c	$\begin{array}{c} 3a(70), \ 4a(0.4), \ 5(0.1) \\ 3a(50), \ 4a(19), \ 5(4) \\ 3a(34), \ 4a(38), \ 5(0.1), \ 6(2), \ 7(2) \\ 3b(68), \ 4b(0.1), \ 5(7) \\ 3b(64), \ 4b(6), \ 5(7) \\ 3b(44), \ 4b(10), \ 5(19), \ 6(0.9), \ 7(13) \\ 3c(73), \ 5(4) \end{array}$
9a) 10 <sup>e)</sup>	c c a	3c(72), 5(5) 3c(51), $4c(7)$ , 5(20), $6(1.4)$ , 7(5.4) 3a(23), 5(17), $6(0.9)$ , 7(5), 8(45)

Table 1. Reaction of 4-Bromo-2, 4, 6-tri-t-buty!-2, 5-cyclohexadien-1-one (1) with<br/>Glycols in the Presence of Pyridine<sup>a)</sup>.

a) All reactions were carried out in the conditions where a mixture of 1 (6.8g, 20 mmoles), glycol (2) (50 ml) and pyridine (3.4 ml, 40 mmoles) were heated in an oil bath at ca. 110°C for 6hr under nitrogen atmosphere with stirring magnetically, unless otherwise indicated.

- b) The yields, based on 1, isolated were shown.
- c) Without stirring.
- d)  $\alpha$ -Picoline instead of pyridine was used in this case, the molar of 1, 2 and  $\alpha$ -picoline =1:2:2.
- e) From M. Tashiro and G. Fukata, Heterocycles, 12, 1551 (1979).

in the case of 2c that 4c, which had not been formed under any other conditions where pyridine was used, could be obtained in yield of 7% besides the other products. Such interesting difference between pyridin and  $\alpha$ -picoline on the formation of 4 might reflect steric factors around the nitrogen atoms on their rings.

#### EXPERIMENTAL

All melting points are uncorrected. IR spectra were mersered on a Nippon Bunko IR-A spectrophotometer as KBr pellets or as liquid films on NaCl pellets. <sup>1</sup>H-NMR spectra were determined at 60 MHz on a Hitachi R-20 spectrometer with TMS as an internal reference. Mass spectra were recorded on a Hitachi R-4 mass spectrometer at 70 eV using a direct inlet system.

General Procedure for the reaction of 1 with Glycol.-A (Run 1, 2, 4, 5, 7 and 8): A mixture of 1 (6.8 g, 20 mmoles), glycol (2) (50 ml) and pyridine (3.4 ml, 40 mmoles) were heated in an oil bath at ca. 110°C for 6hr under nitrogen atmosphere with stirring (or without stirring). After the reaction mixture was cooled down to room temperature, it was extracted with benzene  $(3 \times 100 \text{ ml})$ . The benzene layer was washed with water and after dried it with sodium sulfate, it was evaporated in vacuo to leave a residue. The residue was washed with cold methanol to give compound 4 as crystals. The residue, which was leaved by evaporation of the methanol, was subject to column chromatography on silica-gel (Wako gel C-300) using at first hexane (A) and then benzene (B) and finally ethyl acetate (C) as eluents. Compounds 5 and 6 were obtained from fraction A, 7 and 4 were isolated from fraction B and all of 3 was eluted from fraction C. **B** (Run 3, 6 and 9): A mixture of 1 (3.4 g, 10 mmole), glycol (2) (20 mmole) and  $\alpha$ -picoline (1.86 g, 20 mmole) was treated and worked up as described above.

Physical and spectral data of the pro-

ducts are as the following. The yields of the products are shown in **Table**. **2-(1, 3, 5-tri-t-Butyl-4-oxo-2, 5-cyclohexadien-1-oxy) ethanol** (**3a**): viscous colorless oil, IR (NaCl): 3450, 1665, 1645, 1635 (sh) cm<sup>-1</sup>. <sup>1</sup>H-NMR (CDCl<sub>3</sub>):  $\delta$  0.95 (s, 9H), 1.26 (s, 18H), 2.0 (b, 1H; disappeaed with D<sub>2</sub>O), 3.35, 3.70 (each t, 2H, J= 6Hz), 6.55 (s, 2H). Mass spectrum m/ e: 322 (M<sup>+</sup>). Anal. Calcd for C<sub>20</sub>H<sub>34</sub>O<sub>2</sub>•1/3H<sub>2</sub>O: C,

Anal. Calcd for  $C_{20}H_{34}O_2 \cdot 1/3 H_2O$ : C, 73. 13; H, 10. 64.

Found: C,

73.27; H, 10.48.

3-Oxa-5-(1, 3, 5-tri-t-butyl-4-oxo-2, 5-cyclohexadien-1-oxy) pentanol (3b): viscous colorless oil, IR (NaCl): 3450, 1665, 1645 cm<sup>-1</sup>. <sup>1</sup>H-NMR (CDCl<sub>3</sub>):  $\delta$  0.95 (s, 9H), 1.25 (s, 18H), 2.16 (b, 1H; disappeared with D<sub>2</sub>O), 3.36-3.76 (m, 8H), 6.56 (s, 2H). Mass spectrum m/e: 366 (M<sup>+</sup>). Anal. Calcd for C<sub>22</sub>H<sub>38</sub>O<sub>4</sub>•1/3H<sub>2</sub>O: C, 70.93; H, 10.46.

Found: C,

71.02; H, 10.30.

3, 6-Dioxa-8-(1, 3, 5-tri-t-butyl-4-oxo-2, 5-cyclohexadien-1-oxy) octanol (3c): viscous colorless oil, IR (NaCl): 3450, 1665, 1645 cm<sup>-1</sup>. <sup>1</sup>H-NMR (CDCl<sub>3</sub>):  $\delta$  0.93 (s, 9H), 1.22 (s, 18H), 2.50 (b, 1H; disappered with D<sub>2</sub>O), 3.30-3.80 (m, 12H), 6.56 (s, 2H). Mass spectrum m/e: 410 (M<sup>+</sup>). Anal. Cacd for C<sub>24</sub>H<sub>42</sub>O<sub>5</sub>•1/3H<sub>2</sub>O: C, 69.19; H, 10.32.

Found: C, 69.39; H, 10.10.

1, 2-Bis (1, 3, 5-tri-t-butyl-4-oxo-2, 5-cyclohexadien-1-oxy) ethylene (4a): mp 168.5-170 °C, colroless prisms (MeOH). IR (KBr): 1665, 1645 cm<sup>-1</sup>. <sup>1</sup>H-NMR (CD-Cl<sub>3</sub>):  $\delta$  0.95 (s, 18H), 1.24 (s, 36H), 3.32 (s, 4H), 6.50 (s, 4H). Mass spectrum m/e: 582 (M<sup>+</sup>). Anal. Calcd for  $C_{38}H_{62}O_4$ : C, 78.30; H, 10.72.

Found: C, 78.16; H,

10. 80.

1, 5-Bis (1, 3, 5-tri-t-buty-4-oxo-2, 5-cyclohexadien-1-oxy)-3-oxa-pentane (4b): mp 84.5-85.0°C, colorless plates (MeOH-H<sub>2</sub>O). IR (KBr): 1665, 1645 cm<sup>-1</sup>. <sup>1</sup>H-NMR (CD-Cl<sub>3</sub>):  $\delta$  0.96 (s, 18H), 1.26 (s, 36H), 3.43, 3.67 (each m, 4H), 6.62 (s, 4H). Mass spectrum m/e: 626 (M<sup>+</sup>). Anal. Calcd for C<sub>40</sub>H<sub>66</sub>O<sub>5</sub>: C, 76.63; H, 10.61.

Found: C, 76.54; H, 10.64.

1, 8-Bis (1, 3, 5-tri-t-butyl-4-oxo-2, 6-cyclohexadien-1-oxy)-3, 6-dioxaoctane (4c): mp 77-78°C, colorless prisms (MeOH- $H_2O$ ). IR (KBr): 1665, 1645 cm<sup>-1</sup>. <sup>1</sup>H-NMR (CDCl<sub>3</sub>):  $\delta$  0.92 (s, 18H), 1.22 (s, 36H), 3.38, 3.60 (each t, 4H, J=5 Hz), 3.66 (s, 4H), 6.52 (s, 4H). Mass spectrum m/e: 670 (M<sup>+</sup>).

Anal. Calcd for  $C_{42}H_{70}O_6$ : C, 75.18; H, 10.52.

Found: C, 75.27; H,

10.64.

### REFERENCES

- Part 3. G. Fukata, N. Sakamoto and M. Tashiro, Heterocycles, 14, 1259 (1980).
- E. Müller, K. Ley and W. Kiedaisch, Chem. Ber., 87, 1605 (1954). D. E. Pearson, S. P. Venkaturamu and W. E. Childers, Jr., Synthetic Communication, 9, 5 (1979).
- 2) M. Tashiro, H. Yoshiya and T. Yamato, Synthesis, **1978**, 339.
- M. Tashiro and G. Fukata, Synthesis, 1979, 602.
- 4) M. Tashiro, G. Fukata and H. Yoshiya, Synthesis, **1979**, 988.
- M. Tashiro and G. Fukata, Heterocycles, 12, 1551 (1979).
- 6) When equimolecular amount of ethylene glycol to one mole of 1 was used in the presence of pyridine, the unidentified compound was obtained but not 4a.